KAS-192
FP382-01

United States Patent Application

Title of the Invention

AUTOMATIC ANALYZER

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TITLE OF THE INVENTION

AUTOMATIC ANALYZER

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an automatic analyzer for use in clinical examination to perform qualitative and quantitative analysis of living body samples, such as blood and urine. More particularly, the present invention relates to an automatic analyzer for use with reagent bottles having seals attached to bottle openings, which are pierced at the start of analysis using the reagent bottles.

2. Description of the Related Art

Two types of reagent bottles are mainly used in an automatic analyzer, i.e., a capped reagent bottle which is set in the automatic analyzer by an operator at the start of analysis after removing the cap, and a reagent bottle with a seal which is made of plastic, for example, is attached to a bottle opening to prevent evaporation and deterioration of the reagent, and is ripped by an operator before the start of analysis. When using the latter type of reagent bottle, it is general that the reagent bottle is set in the automatic analyzer by the operator after ripping the seal with a dedicated cutter, a punch or the like. On the other hand, various methods are also proposed so far for automatically piercing the seal by the analyzer itself when the reagent bottle is set in the analyzer. Patent Document 1 (JP, A 11-183484) discloses a method of piercing a seal by

a disposable tip which is fitted to a fore end of a reagent sampling nozzle (arm) and which has a fore end formed into a shape capable of piercing the seal.

SUMMARY OF THE INVENTION

When the operator rips the seal with the dedicated cutter, punch or the like, a position at which the seal is ripped must be adjusted such that the reagent sampling arm passes the ripped portion of the seal. If the size of the ripped portion is increased, close adjustment is not required for the position of the ripped portion, but the sealing function to prevent evaporation and deterioration of the reagent is impaired.

On the other hand, the method disclosed in JP, A 11-183484 requires no adjustment for the piercing position because the fore end of the reagent sampling arm coincides with the fore end of the disposable tip for piercing the seal. In consideration of that the disposable tip and the seal of the reagent bottle are both made of plastic, however, the plastic tip is estimated to face a difficulty in piercing the plastic seal. Also, even if the disposable tip is able to pierce the seal, a risk would arise in that the tip fore end is deformed and the accuracy in, e.g., sampling the reagent lowers. In the case of using the disposable tip made of metal to facilitate piercing of the tip through the seal, the production cost will increase.

Accordingly, it is an object of the present invention to provide an automatic analyzer including a seal-piercing

and reagent-sampling mechanism which is able to positively pierce a seal of a reagent bottle and to eliminate the need of adjustment for alignment between a seal piercing position and a reagent sampling position.

To achieve the above object, the present invention is constituted as follows.

In an automatic analyzer comprising a reagent bottle containing a liquid reagent and having an opening through which the reagent is sampled out of the reagent bottle, the opening being closed by a seal to shield off the reagent from an external atmosphere; a reagent sampling arm for sampling the liquid reagent in the reagent bottle to the outside through the opening; a reaction cell in which a sample is mixed with the reagent sampled by the reagent sampling arm; and measuring means for measuring reaction between the sample and the reagent, the automatic analyzer further comprises a seal piercing tool capable of being fitted over a nozzle of the reagent sampling arm to pierce the seal of the reagent bottle; a stationary container for accommodating the seal piercing tool when not used; and a mechanism for taking the seal piercing tool out of the container and fitting the seal piercing tool to the reagent sampling arm before the start of piercing the seal of the reagent bottle, and for returning the seal piercing tool to the container after the end of the seal piercing.

One or more reagent bottles each having one or more openings may be disposed, and the automatic analyzer may further comprise a reagent-sampling-arm moving mechanism for

moving the reagent sampling arm on a straight line along which the openings of the one or more reagent bottles, the container, and a reagent dispensing position to the reaction cell are arranged.

The seal can be made of any suitable material so long as the material is able to positively shield off the reagent from the external atmosphere. Generally, the seal is made of, for example, paper, plastic, or a metal foil. The above expression "One or more reagent bottles each having one or more openings" is used in consideration of the following. One reagent bottle containing the same reagent may have a plurality of openings. In general, however, a plurality of reagent bottles are molded integrally with each other, and the individual reagent bottles have respective openings. Because the seal piercing tool is repeatedly used, at least a portion of the seal piercing tool brought into contact against the seal is preferably formed of a hard material, such as a metal or ceramic, so that the seal piercing ability will not reduce even after the repeated uses. Also, the contact portion of the seal piercing tool against the seal is preferably formed into a pointed shape suitable for piercing the seal.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 schematically shows the arrangement of a mechanism system of a biochemical automatic analyzer with the reagent bottle piercing function according to the present invention;

Fig. 2 shows part arrangements of a reagent sampling mechanism of the analyzer shown in Fig. 1;

Fig. 3 shows relative positions and part arrangements of a piercing tool and a stripper of the analyzer shown in Fig. 1;

Fig. 4 is an explanatory view for explaining the operation of fitting the piercing tool of the analyzer shown in Fig. 1;

Fig. 5 is an explanatory view for explaining the operation of removing the piercing tool of the analyzer shown in Fig. 1; and

Figs. 6A and 6B show the piercing tool additionally provided with a guide tube fitted over the tool to be slidable along an outer surface.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

An embodiment of the present invention will be described below with reference to Figs. 1 to 5.

Figs. 1 to 3 schematically show the construction of a reagent sampling mechanism 1, a reagent bottle 3, and a stripper 2. Those components are arranged so as to lie on a straight line. The reagent sampling mechanism 1 sucks a reagent from the reagent bottle 3 placed on a reagent disk 4, carries the sucked reagent to the position of a reaction disk 5, and then delivers the reagent into a reaction cell 9 which contains a sample to be measured.

Fig. 4 shows a cycle of successive steps for fitting a piercing tool 6, and Fig. 5 shows a cycle of successive

steps for removing the piercing tool 6. The piercing tool 6 is used in the stage before starting analysis, i.e., at the time when an operator sets the reagent bottle 3 on the reagent disk 4. Usually, the piercing tool 6 is accommodated in the stripper 2 and is fixedly positioned by two leaf springs 8 (see also Fig. 2). Prior to starting the analysis, the operator places a plurality of reagent bottles 3 one by one on the reagent disk 4 in order through a predetermined loading inlet. The reagent bottles 3 are each provided with identification information and are registered in the analyzer by reading the identification information before the reagent bottles 3 are placed on the reagent disk 4. Upon completion of the placement of the reagent bottles 3, the reagent sampling mechanism 1 is moved from a standby position to the position of the stripper 2. Then, as shown in Fig. 4, the piercing tool 6 is attached to a nozzle 7. The piercing tool 6 has a hollow inner space into which the nozzle 7 is inserted. When the nozzle 7 is inserted into the piercing tool 6, a body 11 of the nozzle 7 contacts with a lever 10 provided on the piercing tool 6 (see also Fig. 2). A portion of the body 11 contacting with the lever 10 is formed to have a tapered surface so that the lever 10 is opened along the tapered surface. The body 11 has a slot formed therein to catch the lever 10, and the lever 10 is locked in the slot of the body 11 by a spring force. The piercing tool 6 is thereby fitted over the nozzle 7.

Subsequently, the reagent sampling mechanism 1 including the piercing tool 6 fitted over the nozzle 7 is

moved to a sampling position on the reagent disk 4. Then, the reagent sampling mechanism 1 is vertically moved to pierce the seals of the reagent bottles 3 one by one. Upon completion of the seal piercing of one reagent bottle 3, the reagent disk 4 is rotated and the reagent sampling mechanism 1 starts the operation of piercing the seal of the next reagent bottle.

When the seal piercing operation is completed for all of the reagent bottles 3, the reagent sampling mechanism 1 is moved to the position of the stripper 2 where the piercing tool 6 is removed as shown in Fig. 5. The stripper 2 has a hole formed in its wall to allow insertion of a part of the lever 10. Accordingly, with only lateral movement of the reagent sampling mechanism 1, the lever 10 of the piercing tool 6 is not unlocked from the body 11 of the nozzle 9. When the reagent sampling mechanism 1 is moved upward, a lower part of the lever 10 contacts with an upper edge of the hole in the stripper wall, whereby the lever 10 starts to open. Upon full opening of the lever 10, the lever 10 is unlocked from the nozzle body 11 and the piercing tool 6 is removed from the nozzle body 11. The removed piercing tool 6 is moved downward while being guided by the leaf springs 8, and is returned to the original set position. The stripper 2 has a lever guide to prevent the piercing tool 6 from deviating from the original set position when it returns to there.

The reagent sampling mechanism 1, from which the piercing tool 6 has been removed, is moved to the standby

position and stands ready for the next operation.

Figs. 6A and 6B show another embodiment corresponding to Claim 8. In this embodiment, a slidable guide tube 12 is additionally fitted over the piercing tool 6. The guide tube 12 is biased downward by a spring 13 and hence held in a cushioned state. On the reagent bottle side, a plastic seal having a tapered recess 14 is attached to a bottle opening.

Fig. 6A shows a state during downward movement of the piercing tool 6. Fig. 6B shows a state in which the piercing tool 6 is further moved downward and the guide pipe 12 is engaged in the tapered recess 14. In the state of Fig. 6B, the guide tube 12 is stopped and the piercing tool 6 is pressed downward through a spring cushion, i.e., with compression of the spring 13. Thus, the piercing operation is completed by a pointed needle of the piercing tool 6. When such a reagent bottle with the seal having the tapered recess 14 is used, it is very important to accurately position both the pointed needle and the reagent bottle relative to each other. With no provision of the guide tube 12, the pointed needle pierces into the tapered surface of the recess 14 instead of the center of the tapered recess 14, i.e., a central lowermost portion thereof, if there is a deviation between the pointed needle and the reagent bottle. In the event of a hole being thus formed in the tapered surface of the recess 14, the following trouble occurs. When the sampling nozzle 7 is even slightly deviated from the center of the tapered recess 14 in the step of sampling

the reagent, the nozzle is moved downward while sliding over the tapered surface and then strikes against the central lowermost portion of the tapered recess 14 (now not holed), whereby the nozzle is bent. In this embodiment, with the provision of the guide tube 12 as shown in Fig. 6, the pointed needle and the reagent bottle can be accurately positioned relative to each other in spite of a slight deviation between them. As a result, a hole can be always formed at the center of the tapered recess 14.

According to the present invention, in the automatic analyzer using the reagent bottle with the seal, the piercing tool 6 for piercing the seal of the reagent bottle 3 is fitted over the reagent sampling nozzle 7 of the reagent sampling mechanism 1, and the operation of piercing the seal of the reagent bottle can be performed on the reagent disk 4. A highly-reliable, inexpensive and small-sized automatic analyzer can be hence provided which no longer needs an additional space that has been so far required for the seal piercing and can prevent a deviation between the position of a pierced hole and the position of the nozzle 7.